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The determinants and expression of computer-related anger

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Abstract

Studies of everyday computer-related anger are rare. To shed more light upon this anecdotally common phenomenon, retrospective self-report questionnaires were used to elicit closed-ended and open-ended responses from 126 members of the general public and students in northern England who supplied psychological and behavioral data connected with a single recently experienced occurrence of computer-related anger. Inter alia, findings show verbal and physical aggression towards equipment to be common in bouts of computer anger, and physical aggression to be associated with greater negative affect prior to incidents but not with stress-related factors. However, stress-related factors and negative affect predicted variance in anger intensity over and above cognitive appraisal variables. It is concluded that computer anger is likely to be a source of stress for a small but significant number of people, that computers' non-sentience leads to physical disinhibition, but that evidence that the expression of computer anger in social environments is inhibited by fear of people's negative evaluations is weak. Further conclusions include the observations that anger is likely to be more intense when theoretically relevant cognitive appraisals are made, a person is in an irritable mood and when physiological arousal is elevated because of ongoing events.

Keywords: Computers; Anger; Emotions; Behavior; Stress; Cognitive processes

The determinants and expression of computer-related anger

1. Introduction

1.1 Background

Psychological studies of the anger that people experience in their everyday interactions with computers have been limited. While there has been much research on emotion and computing, this work has tended to focus upon issues such as affective computing (i.e. developing technology that can identify and respond to user affect to enhance the user experience, e.g. el Kaliouby, Picard & Baron-Cohen, 2006; Picard & Klein, 2002), experimental studies of the physiological effects of prolonged system response times (see e.g. Boucsein, 2000), differences in the communication of emotions across computer-mediated and face-to-face situations (e.g. Derks, Fischer & Bos, 2008), and attempting to use computer games to influence the attributions, emotions and behaviors of aggressive school students in aggression provoking situations (Hobbs & Yan, 2008).

Of the few studies of everyday computer anger that do exist, Wilfong (2006) found that extent of anger in imagined computing scenarios was negatively correlated with computer experience and computer self-efficacy, and positively correlated with computer anxiety. Lower self-efficacy has also been shown to be related to negative response valence (a construct encompassing being angry at the computer, oneself and helplessness or resignation) as opposed to positive response valence (determination to fix a problem) resulting from computer frustration (Bessière, Newhagen, Robinson & Shneiderman, 2006). Finally, in a study in which an instrument was developed to measure the emotions experienced by people when learning to use new software packages, Kay and Loverock (2008) found that, prior to a course in which preservice teachers used laptops as an integral part of their course, scores on scales measuring positive affect towards computers, negative affect towards computers, cognitions about teachers' and students' interactions

with computers, and computer self-efficacy were all related (in the directions that would be expected) to scores on a measure of the anger habitually experienced when learning how to use a new software package. Anger was also found to be correlated with other emotions measured (positively with anxiety and sadness, and negatively with happiness), and, among other observations, both anger and anxiety were shown to be reduced between the start and end of the eight month course.

Although the previously mentioned studies on emotional aspects of computing are informative, none of them gave specific consideration to the circumstances underlying individual instances of computer anger and the behavioral expression of this anger. In seeking to address this general gap in the literature, the presently reported study can be considered to make a novel contribution. After briefly reporting on the frequency of computer anger, the study examines the following research questions:

- i) Are factors related to ongoing stress and negative affect related to anger intensity and do they predict anger intensity over and above the cognitive factors said to fully specify the occurrence of anger in Smith and Lazarus' (1990, 1993) appraisal model of anger?
- ii) Are people particularly likely to act upon their impulses to overtly display anger towards the computer because it is a non-sentient entity, especially when they are alone?
- iii) Does greater ongoing stress and negative affect lead to increasingly greater expression of computer-related aggression?

From an applied perspective, studies of computer-related anger are important because computer-related stress is a common feature of advanced societies. For example, over 60% of respondents cited slow program and computer speeds as a common source of stress over a two month period in a US study by Hudiburg (1995). More recently, a UK poll for the Symantec

Corporation showed 86% of people surveyed to have experienced stressful IT-related incidents (Leyden, 2003).

1.2 Computer anger: concept and antecedents

The present article is predicated upon the assumption that computer anger is a common occurrence, that it has the potential to be a major source of stress, and therefore that its causes and the behaviors associated with it are an important topic for research. However, there is little hard data about the frequency with which computer anger occurs. Therefore a preliminary aim of the present study was to obtain data on the frequency of computer anger.

A second presently considered issue was the extent to which ongoing stress and a person's affective state are implicated in instances of computer anger over and above cognitive factors. With respect to the latter, recent work using part of the same data set as that presently analyzed has compared computing and driving anger within the framework of the Smith and Lazarus (1990, 1993) variant of appraisal theory (Charlton & Kappas, in preparation).

As with other versions of appraisal theory, the Smith and Lazarus model seeks to specify the cognitions underlying various emotions. The model splits the appraisal process into two parts; primary appraisals which determine whether an event is of motivational importance and motivationally congruent or incongruent, and secondary appraisals which, assuming that an event is motivationally important and depending upon whether the event is motivationally congruent or incongruent, determine the emotional response. According to the model, anger resulting from frustrating computing situations would be explained by the event being appraised as motivationally important and motivationally incongruent during the primary appraisal process, with anger occurring because an appraisal of other accountability is made during the secondary appraisal process.

The recent work of Charlton and Kappas (upon which the present article builds) found that all three appraisal components taken to fully specify the generation of anger in the Smith and Lazarus model were predictive of anger intensity both when computing and when driving. The observation that other accountability, in the form of computer accountability, was just as highly related to intensity of computer anger as other human accountability was to driving anger intensity is consistent with the idea that people have relationships with, and expectations of, computers which are similar in many respects to the relationships and expectations that they have with regard to other humans (e.g. Ferdig & Mishra, 2004; Reeves & Nass, 1996), although, in general, studies directly comparing humans' responses to inter-human interactions and human-computer interactions show that computer-elicited responses tend to be weaker (Aharoni & Fridlund, 2007). Also, the findings for motivational incongruence and importance suggest that having one's goals blocked is important in computer anger, the blocking of one's goals leading to frustration (which is the most commonly cited negative computing experience – Bessière et al., 2006). In turn, frustration often, but not always, leads to anger.

Consistent with the above, in his landmark series of studies on anger, Averill (1982) found that 'frustration, or the interruption of some ongoing or planned activity' (p.173) was the most commonly mentioned instigator of anger. However, frustration was not usually a sufficient condition for anger: most people also cited other factors including; 'violations of important personal expectations or wishes...(and) violations of socially accepted ways of behaving' (p.173). These seem particularly relevant to computer anger. Thus, given the similarity of people's expectations of humans and computers (e.g. Ferdig & Mishra, 2004; Reeves & Nass, 1996), it can be argued that, for example, when using a word processing program we expect our words to appear on the VDU almost instantaneously, and when this does not happen we become angry both because our goal of finishing our task is being blocked and because the computer is not meeting our expectations. Similarly, the failure of a computer to respond in a timely manner to input might also be said to violate socially accepted ways of behaving. The fact that the above types of goal blocking often

seem to occur for no known reason is also likely to add to anger, experimental work showing that frustrations occurring for arbitrary reasons evoke greater hostility than those which appear more justifiable (Dill & Anderson, 1995).

It is reasonable to propose that, along with cognitive factors, ongoing stress and affective state at the time of an incident should also be implicated in computer anger. Here, Marcus-Newhall, Pedersen, Carlson and Miller (2000) refer to work by Isen and various colleagues (e.g. Isen & Shalker, 1982) showing that negative and positive moods lead people to have more negative and positive perceptions of events respectively, and that the existence of negative moods therefore increases the likelihood of aggression occurring. One useful explanatory framework here is Zillman's (e.g., 1996) concept of excitation transfer, whereby residual autonomic arousal resulting from prior events is transferred to a current event, resulting in greater intensity of emotion. Although computer anger is not always displaced anger, the literature on displaced anger is also of relevance. Anger is said to be displaced when a level of aggression occurs that is disproportionate to the provocation provided by the target because of a failure to respond aggressively towards a previous provocation (Marcus-Newhall et al., 2000). Marcus-Newhall et al. note that Dollard (1938) and Dollard, Doob, Miller, Mowrer and Sears (1939) considered that the three key attributes of targets of displaced anger are that the target acts as an irritant, is available and lacks power, and that even minor provocations by such targets are likely to trigger aggressive behavior in circumstances where a failure to respond aggressively towards a previous provocation results in the energizing of aggressive behavior and a lowering of the threshold for the instigation of such behavior. In addition to computer anger often being disproportionate to the provocation provided by the computer, these three key attributes of targets of anger usually pertain during episodes of computer anger (and when anger is directed towards other inanimate objects too).

Not surprisingly then, mood has previously been shown to be predictive of computer-related frustration (Bessière et al., 2006), and appraisal theorists recognize that moods can lower the threshold at which emotions are triggered and the intensity with which emotions occur. For

example, Roseman and Smith (2001) point out that being in an irritable mood should result in anger more readily occurring, and result in anger of greater intensity, in the presence of the correct configuration of triggers, with Frijda and Zeelenberg (2001) suggesting that mood and heightened arousal might have an influence by making the appraisals considered central to anger more likely to occur. Consistent with this, anger is particularly likely to arise from goal blocking when a person is interrupted while performing a complex task and when a person feels under pressure to complete a task (Izard, 1991). The nature of some computing tasks is particularly likely to make heightened ongoing physiological arousal a factor in many instances of computer anger. For example, many tasks (e.g. word processing and data input) involve rapid cycles of input to, and output from, short-term memory over a sustained period of time. Also, one often finds oneself increasing one's pace of work, possibly because a computer is seen as a partner in a dialog and its speed of response tends to be reciprocated by increased speed of responding on the part of the user (Brod, 1984).

The discussion in the present subsection suggests that the build-up of arousal from ongoing events, a person's mood, the specific properties of the computer, and the nature of much human-computer interaction will combine into a particularly explosive cocktail when problems occur and leads to the following hypotheses:

Anger intensity should increase with...

H1: poorer progress prior to the event,

H2: the perception of being under greater time pressure,

H3: more negative prior affect, and...

H4: these three stress-related and affective factors should have the capacity to explain anger intensity over and above cognitive appraisal factors (motivational importance and incongruence, and blaming the computer or another person).

1.3 The behavioral effects of computer anger

Another major theme of the present article is the expression of computer-related anger: the behaviors displayed, the possible influence of arousal-related factors on them, the effect that being alone or accompanied has on such behavioral manifestations of anger, and the extent to which people feel that they try to restrain their anger when incidents occur.

The general behavioral urge associated with anger is to attack or move against the anger inducing entity (Smith & Lazarus, 1990; Roseman, 2001). More specifically, in his appraisal model, Roseman (2001) specifies the behavioral component of anger as consisting of two action tendencies; hitting and criticizing. In general then, we would expect physical and verbal aggression directed towards the computer to be common behavioral manifestations of computer anger.

When angry, people feel themselves to be highly impulsive and to have low control over their behavior. However, Izard (1977) has argued that although physical aggression is fundamental to anger, when angry we learn to respond verbally, and in a restrained manner, rather than physically, to conform to social norms and to avoid both provoking anger in other people and closing down channels of communication. Also, other factors such as embarrassment at being seen to become angry often lead to the inhibition of overt verbal and physical expression of anger. In considering these issues, Averill (1982) compared the frequency with which verbal and physical aggression occurred in anger inducing situations and found 'verbal or symbolic aggression' to occur in 49% of instances and physical aggression to occur in 10% of instances. However, because anger-related behaviors are often inhibited, Averill noted that overt behaviors, especially physical aggression, cannot be relied upon as an index of anger. He therefore reported data on anger impulses, noting that 82% and 40% of his participants felt impulses to be verbally and physically aggressive towards the instigator respectively. The fact that verbal reactions were more common than physical reactions with respect to both overt behaviors and impulses was interpreted as supporting the idea that human anger is primarily a socially constructed phenomenon. This is

opposed to the idea that human anger is primarily an atavistic biological phenomenon which functions to mobilize one's physical resources in the presence of threat as argued by Izard (1977, 1991).

Anger that occurs in interactions with computers provides a useful domain in which to test the extent to which people are prepared to act out their impulses when the instigator is a non-sentient entity. Although some amount of restraint of physical aggression towards computers is likely to occur in the interests of avoiding damage to computing equipment and oneself, adopting Izards' position for the sake of argument, the above considerations led to the following hypothesis:

H5: The percentage of computer anger incidents involving verbal and physical aggression should be more akin to the percentage that Averill obtained for impulse data than the percentage he obtained for overt data.

The aforementioned hypothesis should be true because of a whole host of factors. Such factors include the fact that socialized prescriptions concerning the display of anger are less likely to be in force when using computers, probable lower embarrassment at displaying anger because the machine cannot register one's loss of emotional control, and the lack of a need to worry both about avoiding closing down channels of communication and avoiding provoking anger in the target, with the attendant realization that fear of retaliation is less of a consideration (fear of retribution being well recognized as a major reason as to why people suppress anger and restrain aggressive impulses – Berkowitz & Harmon-Jones, 2004). Also, for the same reasons, while such a proposition seemed unlikely to be supported from anecdotal observations of people's behavior when they are angry with computers, as another test of the assumption that physical aggression is fundamental to anger as argued by Izard (1977), the following hypothesis was forwarded:

H6: Physical aggression (whether accompanied by verbal utterances or not) targeted at computers should be more common than instances of verbal aggression alone towards computers.

Another factor of interest bearing upon the question of whether human anger in social situations is fundamentally biological (Izard, 1977) or fundamentally constructivist (Averill, 1982) is the issue of whether other people are present or absent in the environment when an anger inducing computing incident occurs. Thus, because concerns about being negatively evaluated by others for exhibiting physical aggression should be reduced in the absence of others, to test further predictions of the biological view, it was hypothesized that:

H7: In the lack of someone else's presence, there should be a shift away from verbal aggression towards physical aggression, and that...

H8: People should report trying to restrain or control their anger less when alone than when in someone else's presence.

Finally, consistent with the previously mentioned work showing that moods influence the likelihood of aggressive behavior and that affective arousal is important in displaced aggression (Marcus-Newhall et al., 2000), in three sub-hypotheses it was hypothesized that:

H9: Greater stress resulting from being under greater ongoing time pressure (H9a) and events proceeding poorly (H9b), and more negative affect prior to an incident (H9c) should result in progressively more aggressive behaviors towards computers; stress and negative affect should be lowest for people exhibiting neither verbal nor physical aggression, higher for people limiting themselves to verbal aggression, and highest for those exhibiting physical aggression.

2. Method

2.1 Design

A nonexperimental design was used, with participants providing quantitative data and written descriptions relating to details of a recent anger inducing incident which occurred while they were using a computer.

2.2 Participants

Participants were a pool of 140 students and members of the public recruited as an opportunity sample both off campus and on the campus of a university in northern England. The only criteria for recruitment were that people had to both use computers and drive cars¹. Prior to analysis, screening of written descriptions of incidents was performed to ensure that all computing incidents were non-social in nature in as far as they were not seen as directly attributable to another person or organization (e.g. the producer of a virus or poor organizational management).

After screening, data for 126 participants was available for analysis. This sample consisted of 26 students, 97 non-students varying in occupation and three cases with unknown occupations. There were 47 males (age range 18 to 70 years, $M = 33.34$ years, $SD = 13.46$ years) and 74 females (age range 17 to 61 years, $M = 29.67$ years, $SD = 9.97$ years). The gender of five participants was unknown. Computing experience data was missing for seven people. The remaining 119 participants had been using computers for a mean of 8.53 years ($SD = 4.98$ years) and estimated that

¹ The requirement to drive a car was associated with the fact that one aspect of the wider project of which this article is part involved comparing computer and driving anger.

they used computers for a mean of 16.18 hours per week ($SD = 12.03$ hours). A small amount of missing data resulted in the effective sample sizes in the analyses always falling slightly below the total number of people providing the screened data as a whole.

2.3 Materials

An appraisal questionnaire asked people to answer questions about the most prominent recent occasion that they had become angry when using a computer. Coverage of the contents of the questionnaire here will be confined to a description of the content relevant to the present article. The questionnaire was largely based on the materials used by Parkinson (2001) in a study of driving anger, with adaptations being made to focus the instrument on computing.

Items asked about frequency of computer anger in the last month, who was present when the single incident described in detail occurred (e.g. was the person on their own or accompanied by one or more partners, friends acquaintances or strangers), and open-ended questions asked for a description of the incident and a description of any behavior (e.g. verbal, physical or none) engaged in as a result of the participant's anger. Cognitive factors were measured using the appraisal questions of Parkinson (2001) and Smith and Lazarus (1993), and argued by the latter authors to be single item face-valid measures of the constructs under examination. Questions here asked about how important to the person the event that they were angry about was (motivational importance), the extent to which the event was something that the person did not want to happen (motivational incongruence), the extent to which they considered someone else to be responsible for the event (other human blame) and the extent to which people felt that the computer hardware / software was to blame for the incident (computer system blame). Items relevant to issues surrounding ongoing stress at the time of the incident asked about the extent to which people were under time pressure to finish what they were doing when the incident occurred (time pressure) and how well things were

proceeding before the incident (prior progress). Other items asked about maximum intensity of anger (anger intensity), and attempts to restrain or control anger (restraint).

Apart from the anger frequency and open-ended questions, people responded to all questions on a seven-point numerical scale from 0 to 6. This number of scale points was lower than those in Parkinson (2001) and Smith and Lazarus (1993), both of which used 11-point scales, since, noting work by Vernon, Kline (2000) recommends that rating scales should have a maximum of seven or nine points. Verbal labels for the extremities of the scales differed according to the wording of the question, but the lower end of each scale always corresponded to a lesser response with respect to the issue concerned (as expressed by the above parenthesized variable labels) and the higher end to a greater response.

The PANAS Scales (Watson, Clark & Tellegen, 1988) were used to gauge prior negative affect. This instrument has been shown by its authors to have acceptable psychometric properties and consists of two scales, one measuring positive affect and one measuring negative affect. Although data for both scales was collected, only that for the latter is reported here. The scales consist of 20 words describing feelings and emotions (10 positive and 10 negative). People were asked to respond by indicating the extent of their feeling with respect to each word prior to the incident by using the instrument's five-point response scale which has numerical labels from 1 to 5 and corresponding verbal labels of very slightly or not at all, a little, moderately, quite a bit and extremely. Cronbach's alpha for the 123 people providing the negative affect data presently reported was acceptable at .81. Summation of responses yields minimum and maximum possible scale scores of 10 and 50 respectively, a higher score indicating greater negative affect.

A number of other instruments were also used since the study was part of a wider project. Among the data collected with these questionnaires was information related to demographic details and amount of time spent computing per week. However, these instruments are not mentioned further since, apart from collection of the aforementioned information, they are of no relevance to the aims of the present article.

2.4 Procedure

The British Psychological Society's Ethical Principles for Conducting Research with Human Participants were adhered to. All participants were adults capable of giving informed consent. Confidentiality was assured and participation was voluntary. A general outline of what participants would be required to do was provided before participation, but prior briefing as to the specific aims of the study was not possible so as to avoid influencing participants' responses. However, participants were fully debriefed after participation.

People were recruited on a face-to-face basis by research assistants who gave a short briefing. On agreement to take part, participants were given questionnaires to complete in their own time, arrangements being made with the assistants as to how and when completed questionnaires would be returned. Questionnaires were completed in no specific order, debriefing occurring on their return.

3. Results

3.1 Anger frequency

Computer anger frequency data was available for 124 participants. Descriptive analysis of the data showed that, although the majority of people became angry less than 10 times per month, 13 people (10.48%) became angry 10 or more times per month and one outlying person reported anger as occurring 40 times per month. Excluding this outlier, the mean number of times people became angry while computing was 3.76 times ($Mdn = 3.00$, joint modal values = 1 and 2, $SD =$

3.99).

3.2 Cognitive, stress-related and affective factors as predictors of computer anger intensity

To test whether ongoing stress and affective factors (poor progress prior to the event, being under time pressure and negative affect) were correlated with anger intensity (H1, H2 and H3) and whether these factors were implicated in explaining differences in computer anger intensity over and above cognitive factors (H4), Pearson's r analyses and a two stage hierarchical regression analysis were performed, with cognitive variables (motivational importance, motivational congruence and blaming the computer or another person) entered at the first stage in the regression procedure and stress and affect variables entered at the second stage. In that it allows the amount of variance in a criterion variable accounted for by blocks of variables entered at different stages of an analysis to be assessed, the regression analysis was particularly suited to assessment of the hypothesis that ongoing stress and affect would augment the amount of variance in anger intensity accounted for by cognitive factors. The correlations between the variables in the analysis are shown in Table 1, from which it can be seen that, as discussed at length in Charlton and Kappas (in preparation), of the cognitive variables, motivational importance, motivational incongruence and computer system blame were significantly positively correlated with maximum anger intensity. Other human blame was not correlated with maximum anger intensity, as would be expected given that computing incidents in which blame was directly attributable to other people were screened out of the data set (this variable was only included in the analysis in the interests of comprehensiveness). There was support for hypotheses H1 through H3 in that all three of the stress-related and affective variables were also correlated with maximum anger intensity in the hypothesized directions. Thus, computer anger intensity rose as the incident was increasingly considered to be important, to be something that people did not want to happen, as people

increasingly blamed the computer system, were making poorer progress before the incident (H1), felt under greater time pressure (H2), and were in an increasingly negative affective state (H3).

(Table 1 about here)

From Table 2 it can be seen that at the first stage of the multiple regression analysis computer system blame and motivational importance were independently predictive of computer anger intensity, but motivational incongruence and other human blame were not significantly predictive. Together, these four cognitive variables were significantly predictive, $F(4, 117) = 8.07$, $p < .01$. At this stage, around 22% of the variance in computer anger intensity was accounted for, $R = .47$, $R^2 = .22$. Table 2 shows that computer system blame and motivational importance continued to be significantly predictive when the stress and affect variables were added at the second stage of the analysis, and that, of the three newly added predictors, only prior progress proved to be independently predictive of computer anger intensity (albeit that the test for negative affect was marginal: $p < .10$). However, en masse the stress and affect variables accounted for a significant extra 6% of variance over and above the cognitive variables, $R^2 \text{ Change} = .06$, $F \text{ Change}(3, 114) = 3.33$, $p = .02$, thereby supporting the hypothesis (H4) that stress and affective factors should be important over and above cognitive factors in accounting for computer anger intensity. Overall, for the seven predictor variables present at stage two, 28% of the variance in computer anger intensity was predicted, $R = .53$, $R^2 = .28$, and overall prediction was significant, $F(7, 114) = 6.31$, $p < .01$.

(Table 2 about here)

3.3 Behavioral differences in the expression of anger

(Table 3 about here)

As expected, Table 3² shows that many people's anger manifested itself as verbal and physical aggression towards computing equipment. Comparison of percentages in the table with those observed by Averill (1982) for overt behavior and impulses, shows that overall, around 56% of participants directed verbal or symbolic aggression towards computing equipment (facial expression currently being classified as symbolic aggression), which, contrary to H5, is more similar to the 49% of participants exhibiting overt verbal and symbolic aggression than the 82% reporting impulses towards such aggression in Averill's study. But Table 3 also shows that roughly 36% of participants engaged in physical aggression in the present computing situations, in accordance with H5, this providing a closer match to the 40% of Averill's participants feeling impulses towards physical aggression than to the 10% of his people displaying overt aggression. The fact that there was more verbal and symbolic aggression than physical aggression did not support H6, which suggested the opposite.

Because it allows the extent to which membership of categories of one nominal variable are associated with membership of categories of another nominal variable, a chi-square test of association was performed to test the hypothesis (H7) that, compared to when someone else was present, there would be a shift away from verbal aggression towards physical aggression expression when a person was alone. In the 3 x 2 test of association, the three categories for the anger expression variable were neither verbal or physical anger expression vs. verbal only anger expression vs. physical anger expression (this last category being either with or without verbal expression), and the two categories for the situation variable were alone vs. someone else present. The cross-tabulation of the observed and expected frequencies for this analysis is shown in Table 4, from which it can be seen that, although the absence of any verbal or physical behavior directed at

² The figures in Table 3 differ from those in Tables 4 and 5 because people often exhibited more than one type of behavior and were allotted to more than one category.

the computer was not associated with whether or not another person was present when an incident occurred, there was a slight association whereby, consistent with H7, physical expression of anger was more likely to occur when a person was alone and anger was more likely to be limited to verbal utterances when at least one other person was present. However, the chi-square test result was non-significant, $\chi^2(2) = 2.75$, asymptotic two-sided $p = .252$, and the effect size was small, $w = 0.15$ (Cohen, 1988). Therefore it was concluded that there was insufficient support for H7.

With respect to H8, as hypothesized, self-reports of attempts to restrain or control anger showed less restraint for people who were alone when the computing incident occurred ($n = 74$, $M = 3.12$, $SD = 1.65$) than for those who were in company when the incident happened ($n = 49$, $M = 3.47$, $SD = 1.58$). However, this difference constituted a small effect size ($d = .22$ – Cohen, 1988) and an independent samples t -test, conducted to assess the difference between the two means, showed that this difference was non-significant, $t(121) = 1.17$, $p = .13$ one-tailed. Again then, there was no reliable evidence that the presence of others had a restraining effect on computer anger as suggested by H8.

(Table 4 about here)

To test the general hypothesis (H9) that greater expression of anger would be associated with greater stress and more negative affect, three single-factor between participants ANOVAs were performed to test each of the sub-hypotheses. The three analyses allowed individual assessment of the extent to which means for the three different dependent variables (time pressure, prior progress and negative affect) differed with respect to the anger expression variable's three levels (neither verbal nor physical aggression vs. verbal aggression only vs. physical aggression either with or without verbal expression). The descriptive statistics for these analyses are provided in Table 5³, from which it can be seen that only for negative affect (H9c) were differences in means

³ Despite total sample sizes being the same, slight differences in subsample sizes for the different behavioral categories in Tables 4 and 5 arose from slightly different patterns of missing data for the variables involved in each analysis.

in the hypothesized order, with the physical aggression group being in the most negative affective state just before the incident, followed by the verbal only group and then the group displaying neither of these types of aggression. Contrary to sub-hypothesis H9a, people displaying neither type of aggression felt under greater time pressure, but, consistent with H9b, were happiest with their progress prior to the incident. Also consistent with sub-hypotheses H9b and H9a respectively, things were proceeding better for those displaying only verbal aggression compared to those displaying physical aggression, and those displaying physical aggression were under (marginally) greater time pressure than those displaying only verbal aggression.

(Table 5 about here)

The ANOVAs for time pressure, $F(2, 118) = 0.72$, $p = .49$, partial $\eta^2 = .01$, and prior progress, $F(2, 118) = 1.29$, $p = .28$, partial $\eta^2 = .02$, showed non-significant main effects for behavior, resulting in the rejection of sub-hypotheses H9a and H9b. However, consistent with H9c, the main effect of anger expression for negative affect was significant⁴, $F(2, 73.44) = 8.53$, $p < .01$, partial $\eta^2 = .10$. Because of heterogeneity of variance and unequal sample sizes the Games–Howell procedure was used for post hoc examination of differences in negative affect (Howell, 2007). Here, a significant difference was found between the group displaying physical aggression and that displaying neither physical nor verbal aggression, mean difference = 3.55, $p < .01$, with other tests being non-significant; physical aggression vs. verbal aggression only, mean difference = 2.22, $p = .10$; verbal aggression only vs. neither physical nor verbal aggression, mean difference = 1.33, $p = .17$. Thus, of the three stress and affect variables, only the extent to which negative affect was experienced at the time of an incident was related to differences in the type of anger expression exhibited in the manner suggested by sub-hypothesis H9c, but such affect differed only between

⁴ The Welch test is reported for the negative affect dependent variable because of heterogeneity of variances.

people displaying physical aggression towards computing equipment and those displaying no verbal or physical aggression.

4. Discussion

Although computer anger was not highly frequent for most people, one person reported experiencing anger forty times per month and 10% of people reported anger as occurring ten times or more per month. When coupled with the fact that verbal and physical aggression towards computing equipment was often a concomitant of anger, this confirms the idea that, for some people at least, computer anger is likely to be a significant source of stress both in the workplace and elsewhere and that it is therefore an important area of research.

The fact that anger commonly manifested itself in the forms of verbal and physical aggression towards equipment reflected the two action tendencies (hitting and criticizing) associated with anger in Roseman's (2001) appraisal model. Also, the frequent occurrence of physical aggression suggests that, compared to interactions between humans, when using computers, there is some tendency towards physical disinhibition because the target of the anger is a non-sentient object, with all of the attendant disinhibiting factors mentioned in the Introduction. This gives support to Izard's (1977) contention that physical aggression is fundamental to anger but that we learn to respond verbally in social situations. Also consistent with Izard's (1977) argument, there was a slight association whereby aggression was proportionately more likely to escalate into a physical form when people were alone but proportionately more likely to be restricted to a verbal form when people were in company. However, this observation was not statistically reliable, and the associated research hypothesis (H7) was therefore rejected. Likewise, although the difference was again in the hypothesized direction, evidence for the hypothesis (H8) that people who were in the company of other people when computing incidents occurred would feel that they tried to

restrain or control their anger to a greater extent than those who were alone at the time of incidents was also statistically unreliable. It therefore seems reasonable to say, first, that there is insufficient evidence to conclude that the expression of computer anger in social environments is inhibited by fear of being negatively evaluated by others, and, second, that the study of computer anger provides mixed evidence in favor of Izard's contention that physical aggression has primacy over verbal aggression in anger. This latter conclusion is bolstered by the fact that, overall, unsurprisingly, there was no support for the hypothesis (H6) that physical aggression is more common than verbal aggression when computing.

Findings were also mixed with respect to the hypothesis (H5) that the percentage of computing incidents involving verbal and physical aggression would be more similar to Averill's (1982) data concerning impulses than actual behaviors. As with many of the other behavioral propositions examined, this was suggested as a possibility because prescriptions against extreme displays of anger in social situations, and other factors such as embarrassment at displaying anger, are less relevant when anger is directed at a computer system than when it is directed at a person. A comparison with Averill's percentages for verbal aggression showed that the current percentage of people directing verbal aggression towards computing equipment was more in line with the percentage of people exhibiting overt verbal and symbolic aggression than those reporting impulses towards such aggression in Averill's study, this failing to support H5. However, the data for physical aggression did support H5, the percentage of people engaging in physical aggression in the present computing situations approaching the percentage of Averill's people feeling impulses towards physical aggression and being much greater than the percentage displaying overt aggression. Thus, although differences between Averill's impulse data and overt anger expression data did not differ much across the verbal / symbolic and physical aggression categories (there was a 39 percentage point difference between the 49% of people displaying verbal or symbolic aggression and the 10% of people displaying physical aggression, and a 42 percentage point difference between the 82% of people feeling impulses towards verbal or symbolic aggression and

the 40% of people feeling impulses towards physical aggression), the above observations provide some evidence that the release of restraint in computing situations is greater for more extreme (physical) behaviors compared to less extreme (verbal) behaviors. Further studies of why this might be the case would be useful, one possibility being that, despite the mixed evidence from the present data referred to above, physical aggression is indeed fundamental to anger as Izard (1977) suggests.

There were no statistically reliable findings regarding the sub-hypotheses that increasingly aggressive anger-related behaviors while computing would be associated with greater stress, in terms of people being under time pressure to finish what they were doing when the incident occurred (H9a) and things proceeding less well prior to the incident (H9b). However, although there was no reliable difference between people limiting themselves to verbal aggression and those displaying physical aggression, consistent with sub-hypothesis H9c, people exhibiting physical aggression reported experiencing more negative affect in the time leading up to incidents than those exhibiting neither physical nor verbal aggression. It can therefore be concluded that greater ongoing stress does not appear to be related to greater expressiveness of computer anger and that only negative affect at the time of an incident is related to the extent to which aggressive behaviors occur in the context of computer anger, and that such affect only differs between people displaying the most extreme behavior (physical aggression) and those displaying no aggressive behaviors. At least to some extent then, this result suggests the generalization to human-computer interactions of previous findings showing that the existence of a negative mood increases the likelihood of aggression occurring (see e.g. Marcus-Newhall et al., 2000). Two final points worthy of mention for the behavioral data are that, contrary to what might be expected from the observation that extent of anger in imagined computing scenarios is negatively correlated with computing experience (Wilfong, 2006), behavior did not vary with computing experience, nor did it vary across gender (these results were not presented in the interests of economy).

Although increases in the two stress-related variables were not related to increasingly more aggressive anger-related behaviors as predicted by sub-hypotheses H9a and H9b, along with

negative affect, they were both correlated with computer anger intensity as predicted by hypotheses H1, H2 and H3. Because of intercorrelations among predictor variables, time pressure and negative affect were not independently predictive of anger intensity. Nevertheless, in support of H4, en masse, the stress and affect variables predicted variance in anger intensity over and above the cognitive factors (which as a group were also significantly predictive of anger intensity). In accordance with the view of appraisal theorists such as Roseman and Smith (2001), these findings confirm the notion that computer anger is likely to be more intense when the relevant cognitive appraisals are made and a person is in an irritable mood, and uphold the idea that elevated physiological arousal associated with ongoing events (e.g. Zillman, 1996) can help explain differences in the intensity with which computer anger is experienced.

4.1 Applications, limitations and future research

The present study has shown that computer anger is likely to be a regular source of stress for a small but significant number of people, particularly within working environments where time pressure is an exacerbating factor. For both productivity and occupational health reasons it would seem important for employers to acknowledge the importance of computer-related frustration and anger and to take reasonable steps towards their amelioration. Here, in addition to ensuring that computer hardware and software are adequate for the purposes for which employees are expected to use them, one obvious step would be for employers to consider advising employees of simple anger management strategies.

Perhaps the most important limitation that might be suspected of the study was its use of retrospective self-report questionnaire methodology. In particular, in the appraisal theory literature it has been argued that responses to self-report questionnaires might be more influenced by people's beliefs and scripts surrounding the causes of emotions rather than representing veridical accounts of

processes responsible for emotions (see e.g. Kappas, 2001). Such arguments are consistent with the idea that emotions are the product of unconscious processing and that it is therefore not possible for people to introspect accurately as to the processes that cause their emotions (LeDoux, 1999). It could, then, be argued that some people might not have had a clear memory of the psychological antecedents and concomitants of the anger inducing incidents they reported and, for example, drew inferences as to how they must have felt based upon the intensity of anger that they recalled feeling and upon the behavior that they exhibited. On the other hand, Schorr (2001) notes that it has been argued that there is a ‘... systematic correspondence ... between the implicit theories on emotion elicitation collected from research subjects via questionnaire ... and their actual appraisals that elicit emotions...’ (p.337).

Currently, research has only begun to scratch the surface of the psychology of everyday computer-related anger, and many interesting avenues remain to be explored. For example, studies of stress and affect-related issues might consider whether anger is particularly likely to occur because computers are multifunctional devices, and whether high arousal caused by multitasking, such as simultaneously using a word processor and monitoring incoming e-mails, primes people to react with greater anger when a goal blocking event occurs (whether this event takes the form of a computer malfunction or any other type of interruption). Also, because the present project only looked at single events it was only possible to look at factors tied to each event in the current study. However, diary studies, along the lines of that of Bessière et al. (2006), relating habitual modes of anger expression across many events to demographic, attitudinal and experiential factors would be useful.

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Table 1

The correlation matrix for variables in the hierarchical multiple regression analysis for the prediction of computing anger intensity by cognitive, stress-related and affective factors ($N = 122$).

	Computing anger intensity	Computer system blame	Other human blame	Motivational importance	Motivational incongruence	Time pressure	Prior progress	Negative affect
Computing anger intensity	-----							
Computer system blame	.23**	-----						
Other human blame	.12	.07	-----					
Motivational importance	.43**	.16*	.08	-----				
Motivational incongruence	.29**	.16*	.05	.63**	-----			
Time pressure	.33**	.05	.04	.49**	.36**	-----		
Prior progress	-.19*	-.04	-.03	.01	-.01	-.10	-----	
Negative affect (PANAS)	.20*	-.07	-.13	.11	.10	.20*	-.25**	-----

* $p \leq .05$, ** $p < .01$ one-tailed, $df = 120$.

Table 2

Hierarchical multiple regression statistics for the prediction of computer anger intensity from cognitive, stress-related and affective factors ($N = 122$).

	<i>sr</i>	<i>B</i>	<i>SE</i>	Beta	<i>t</i>	<i>p</i> one-tailed
Stage one						
Computer system blame	.16	.19	.10	.16	1.93	.03
Other human blame	.07	.05	.05	.07	0.91	.18
Motivational importance	.30	.28	.08	.39	3.64	<.01
Motivational incongruence	.01	.01	.08	.02	.17	.43
Stage two						
Computer system blame	.17	.21	.10	.17	2.11	.02
Other human blame	.09	.05	.05	.09	1.09	.14
Motivational importance	.24	.24	.08	.33	2.96	<.01
Motivational incongruence	.00	.00	.08	-.01	-0.44	.48
Time pressure	.10	.07	.06	.11	1.20	.12
Prior progress	-.13	-.13	.08	-.14	-1.67	.05
Negative affect (PANAS)	.13	.04	.02	.14	1.59	.06

Note. *sr* = semipartial correlation.

Table 3

Percentages and frequencies of people manifesting different types of behavior during episodes of computer anger.

	Situation					
	Alone		Other(s) present		Total	
	<i>(n = 74)</i>		<i>(n = 49)</i>		<i>(N = 123)</i>	
<u>Behavior</u>	% ^a	<i>(n)</i>	% ^a	<i>(n)</i>	%	<i>(n)</i>
Verbal aggression against person	1.4	1	6.1	3	3.3	4
Verbal aggression against object	52.7	39	59.2	29	55.3	68
Physical aggression against object	40.5	30	28.6	14	35.8	44
Non-aggressive verbal behavior	1.4	1	2.0	1	1.6	2
Self-directed anger	0.0	0	2.0	1	0.8	1
Facial expression	1.4	1	0.0	0	0.8	1

^a Percentages are within situation

Table 4

Observed and (expected) frequencies for the chi-square test of the association between behavior expressed and context of computer anger ($N = 123$).

		Behavior towards object			
Context		Neither verbal nor physical	Verbal only	Physical	Total
Context	Alone	21 (20.5)	23 (27.1)	30 (26.5)	74
	Other(s) present	13 (13.5)	22 (17.9)	14 (17.5)	49
	Total	34	45	44	123

Table 5

Descriptive statistics for tests on stress and affect variables across different types of computer-related behavior ($N = 121$).

	Neither verbal nor physical ($n = 31$)		Verbal only ($n = 46$)		Physical ($n = 44$)	
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>
Time pressure	4.00	2.03	3.41	2.10	3.57	2.24
Prior progress	4.19	1.42	4.00	1.41	3.68	1.38
Negative affect (PANAS)	11.52	1.81	12.85	4.47	15.07	5.53